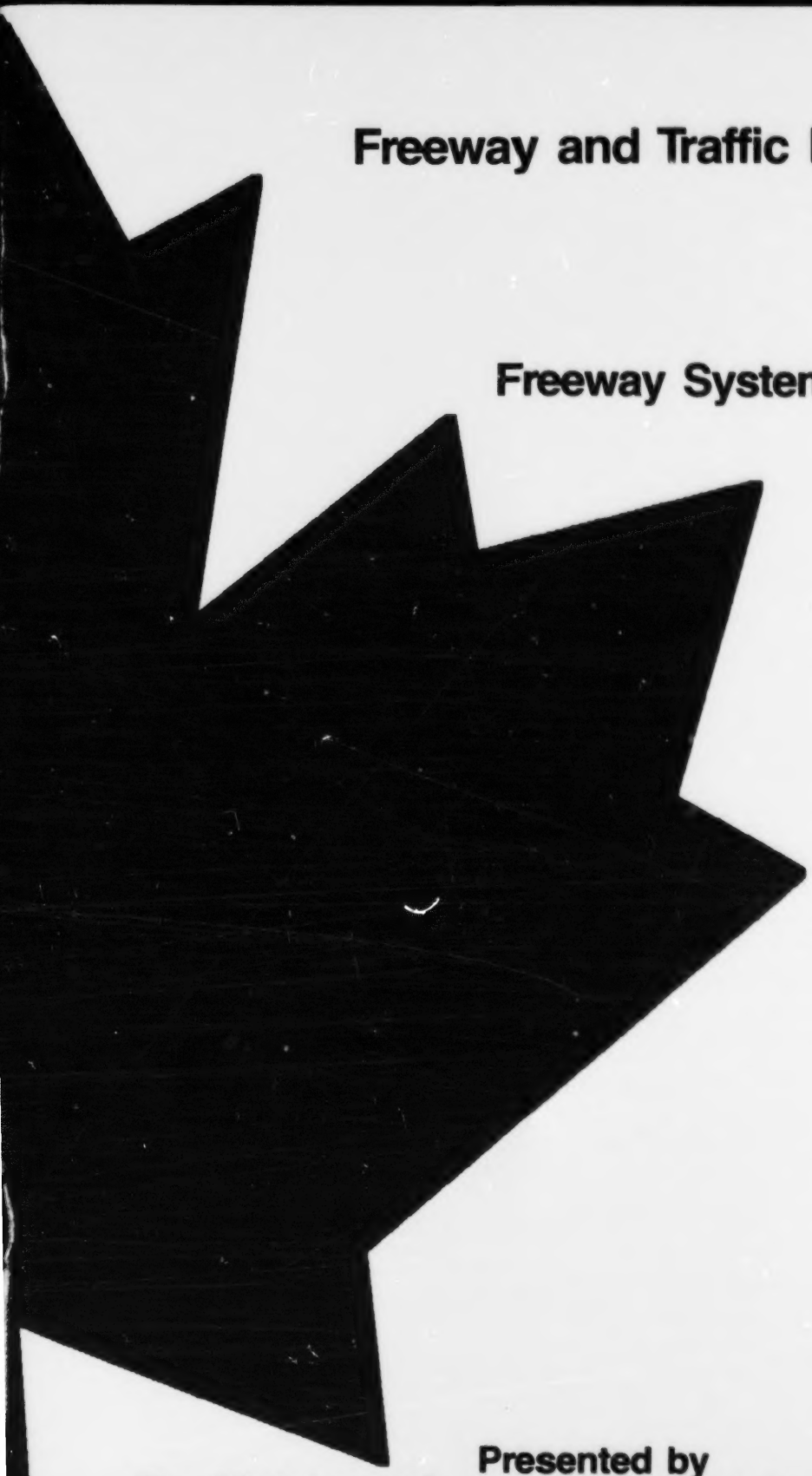
Freeway and Traffic Management

Freeway Systems Management



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Freeway Systems Management

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1/ INTRODUCTION

The following text attempts to relate Ontario's experience in freeway traffic management to the Saudi Arabian context. Although the two nations differ widely in many geographical and cultural aspects, the causes of many of the traffic problems are similar and many of the alleviation strategies are transferable. The first three sections deal with freeway problems, traffic management strategies, and system elements and form the bulk of the text. The last two sections briefly outline the planning, implementation, and operation issues.

2/ COMMON FREEWAY PROBLEMS

2.1/ Congestion

The most common and visible problem on freeways is traffic congestion. Recurring traffic congestion occurs on a regular daily basis, usually during peak periods of traffic demand. Non-recurring traffic congestion occurs any time there is an accident or incident on the freeway.

2.1.1/ Recurring Congestion

The major cause of recurring congestion is a traffic demand volume in excess of 85% of the capacity of the freeway. At this point, average traffic speeds begin to reduce from the normal free-flow speed of 100 km/h down to 50 km/h or less. As the demand volume approaches the freeway capacity, the speeds can drop to"stop and go" driving, with average speeds less than 10 km/h.

Other factors contribute to recurring congestion:

- High truck/bus percentages reduce the effective capacity, particularly if there are grades on the freeway.

- On-ramps with high traffic volumes can cause local congestion downstream of the ramp, particularly if there is a signalized intersection on the arterial road, causing platoons of vehicles to enter the freeway.

- In peak periods, urban freeways tend to act as distributors of traffic, as opposed to carriers of through traffic, resulting in considerable weaving and corresponding reduction in capacity.

- During peak periods, when freeways are congested, the arterial network adjacent to the freeway is usually congested.

2.1.2/ Non-Recurring Congestion

Non-recurring congestion is primarily caused by accidents or incidents on the freeway, particularly when they block one or more lanes, during the peak periods.

The capacity reduction of the freeway, due to lane-blocking incidents, is proportionately greater than the geometric reduction in the number of lanes. When one lane is blocked out of three lanes, the reduction in capacity is 44%. When the shoulder is blocked, there is a 15% reduction in freeway capacity even though no lanes are blocked.

The following are typical duration times in Ontario for a lane-blocking incident:

- detection time - 9 min
- police response time - 7 min
- emergency vehicle response time - 15 min
- collision investigation on shoulder - 30 to 40 min

If the lane-blocking duration time on a typical freeway during the peak period can be reduced by one minute, the resultant saving in vehicle hours of congestion is 80 to 100 vehicle hours.

2.2/ Accidents

There are two types of accidents:

1/ Primary accidents are those caused by driver error, mechanical failure, weather conditions, etc.

2/ Secondary accidents are those caused by congestion following the primary accident.

2.2.1/ Primary Accidents

Areas on the freeway that have significant weaving and merging have much higher accident rates than the rest of the freeway. Examples of this are interchange ramps and transfer lanes (from one part of the freeway to another).

The accident rates on weekends and holidays are usually higher than weekdays, probably due to less experienced drivers being on the road.

Heavy vehicles, such as trucks and buses, experience three times the breakdown rate of light vehicles.

2.2.2/ Secondary Accidents

The probability of secondary accidents occurring increases with the accident/incident duration time and with the lack of warning to drivers of unusual conditions ahead.

2.3/ Other Problems

Inclement weather reduces capacity by 10% (wet pavement, showers, etc.) to 40% (icy pavement, snow storms, etc.). In Ontario, inclement weather occurs during 20% of all peak periods.

Special events (e.g., sports events, religious events, etc.) can cause high-demand volumes and congestion on some sections of freeway.

Maintenance on the freeway can cause severe congestion, particularly if it cannot be scheduled outside the peak periods.

Although congestion is usually described in terms of increased travel time, other associated costs include extra energy consumption and increases in air pollution.

3/ FREEWAY TRAFFIC MANAGEMENT SOLUTIONS

3.1/ Aim

The basic objectives of freeway traffic management systems (FTMS's) in Ontario are to minimize the detrimental effects associated with both recurring and non-recurring congestion. These effects include travel delays, accidents, air pollution, and energy consumption. Other benefits that are less tangible include the ability to collect and analyse vast amounts of freeway traffic data, the provision of better service to the motorists through faster detection and response to incidents, and the provision of real time information, which reduces their frustration.

These objectives are applied to freeway traffic management in Ontario and would be applicable in other countries.

3.2/ Strategies

In order to achieve the objectives described above, a variety of possible solutions and strategies are available, which would be applied in varying degrees depending on the emphasis which is placed on each of the objectives. Many of these strategies have been used successfully in Ontario and other FTMS's throughout the world and can be implemented with confidence. Some will be unique to each situation and will require development, testing, and some operational experience before they can be properly implemented.

These strategies could include the following:

- entrance ramp controls
- lane control signing
- changeable message signing
- priority treatment for high-occupancy vehicles
- incident detection and management
- emergency telephone service
- citizens'-band radio monitoring
- emergency patrols
- corridor control

3.2.1/ Strategies that Grow with Experience

The approach adopted in Ontario is not to "reinvent the wheel" but, rather, to build upon the experiences of others by using successful techniques developed elsewhere and adapting them to the specific situation in Ontario. The same methodology can apply in other countries. Where possible, strategies that can grow in complexity as experience is gained should be selected.

For example, if the major problem was one of recurring congestion, then a system that relied on entrance ramp controls would probably be the most appropriate.

Entrance ramp control, or ramp metering as it is also called, has been used in several jurisdictions to control the optimum rate of entry of vehicles to the freeway from the entrance ramps. Entrance ramp control can be implemented in stages, with an increasing amount of sophistication and co-ordination at each stage. There would be no need to implement the most sophisticated entrance ramp control strategy from the first day of system operation. The system can be built up gradually, with each stage being embarked upon as comfort and confidence are gained in the previous stage.

When Ontario implemented entrance ramp controls on the Queen Elizabeth Way in its freeway traffic management system demonstration project, it was done in a gradual fashion. Initial implementation consisted of isolated ramp metering installations. The entrance ramp was controlled based on the local traffic conditions surrounding that particular ramp. The equipment needed for this was simple, and each installation worked independently. In the second stage, the ramp metering controllers were interconnected by a hardwire system.

This provided the ability to manually control the metering rates of all the ramp metering controllers from a central facility. Later, a computer was added at the central facility, and this allowed for the automatic selection of ramp metering rates and the development of sophisticated control algorithms.

The foregoing discussion described one subsystem of an overall freeway traffic management system, but the same general philosophy applies to the whole system. The complexity of the strategies applied can be increased as the operating authority gains experience.

3.2.2/ Strategy Progression and Staging

One of the first things that could be done for the implementation of an FTMS is the introduction of an emergency patrol system similar to the one operating in Ontario. This would involve purchasing vehicles equipped to provide emergency services to freeway motorists. These services could include towing, water, gas, air, changing tires, and fixing minor mechanical problems. The vehicles would be equipped with two-way mobile radio and operated by personnel who are capable of providing emergency services. These vehicles could patrol the freeways in search of any problems, with the intent being to identify and remove the problems as quickly as possible so that traffic can be restored to its normal condition in the shortest possible time. Some problems would be attended to by the emergency patrol personnel, and others would be reported via two-way radio to the police.

In the second stage of implementation, an emergency telephone system could be installed and would provide better coverage, identification, and definition of any problems, which would then be attended to by the emergency patrol personnel or the police.

In the third stage, a closed-circuit television system (CCTV) could be implemented. This would provide a visual means of monitoring the conditions on the freeway. A CCTV has the advantage of being able to obtain first-hand information without actually having to be at the scene of any traffic congestion. The closed-circuit television system can be manually controlled by a system operator. Technology for this type of system is widely available and does not require a significant degree of training or experience to operate.

In a fourth stage of implementation, an automatic data collection system could be introduced. This would provide an automatic monitoring system to provide real time quantitative measures of the traffic conditions on

the freeway. The installation of loop detectors, a communications system, and a computer would be required.

In subsequent stages of implementation, changeable message signs and lane-control signs could be used to provide information to the freeway users and thereby exercise freeway mainline control through driver information systems. Highway advisory radio could be implemented to provide more complex messages to the freeway and non-freeway users. Entrance ramp controls could be utilized as another stage, to provide a more direct means of controlling freeway traffic.

As confidence is gained in operating the FTMS, steps could be taken to integrate the freeway system with the adjacent arterial road system to optimize both systems for their mutual benefit. This strategy is commonly termed "corridor control." The corridor control strategy could eventually be expanded to cover the entire freeway and arterial network in an urban area and, thereby, provide total network optimization.

The freeway traffic management systems which are currently being designed and implemented in Ontario are essentially configured as shown in Figure 1.

More details of system elements will be provided in Section 4 of this paper.

3.3/ Benefits

As described above, the benefits attributable to freeway traffic management systems could be quantified in terms of savings in travel delays, increased safety, reduction in emitted pollutants, and energy savings.

Other non-quantifiable benefits include the reduction of driver frustration, more efficient and effective operational interfaces, better maintenance operations, and better data collection and analysis.

The experience measured from Ontario's freeway traffic management system demonstration project is compared to other freeway traffic management systems in the United States of America, and the results are shown in Figure 2. Similar improvements could be expected in other countries.

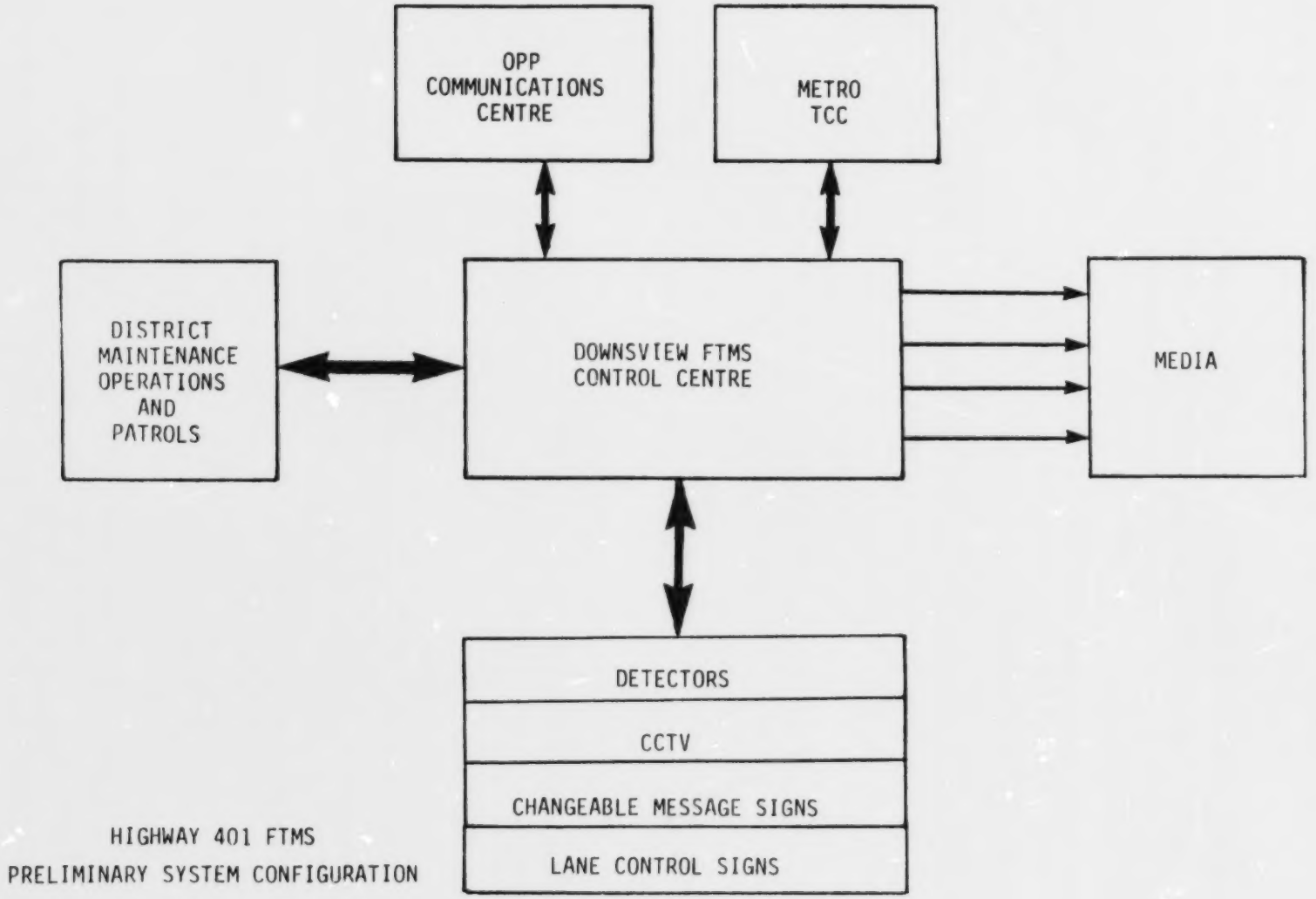


Figure 1/ Configuration of FTMS in Ontario

	VEHICLE HOURS OF TRAVEL	VEHICLE MILES OF TRAVEL	AVERAGE SPEED	COLLISION EXPERIENCE
CHICAGO	-10%	+ 6%	+25%	-17%
HOUSTON	-25%	+10%	+60%	-27%
LOS ANGELES	-27%	+ 6%	+50%	-
MINNEAPOLIS	-16%	+ 3%	+22%	-
Q.E.W. MISSISSAUGA	-21%	-	+45%	-22%

Figure 2/ Benefits Achieved by FTMS Improvement in Freeway Traffic Parameters

4/ FTMS SYSTEM ELEMENTS

Elements of an FTMS are selected and employed to perform the functions necessary to achieve desired FTMS strategies. The purpose and principles of operation of common FTMS elements are explained in the following.

4.1/ Detection Subsystem

Function

- Acquire real time data for FTMS operation.
- Monitor traffic flow for speed, volume, occupancy (vehicle density), and vehicle classification.
- Use data to automatically detect congestion causing incidents and accidents.

Components and Configuration

- Underpavement vehicle loop detectors, detector amplifier, microprocessor, equipment cabinet, etc. (see Figure 3).
- Typically installed singularly or in pairs about every 650 m in each freeway lane; also installed on ramps.

4.2/ Closed-Circuit Television (CCTV) Subsystem

Function

- Verify incidents identified by detection subsystem.
- Identify details of incident to determine appropriate response.
- Monitor incident management.

Components and Configuration

- Cameras, camera control equipment, monitors, camera pole (15 m), equipment cabinet, and maintenance area for bucket truck (see Figure 4).
- Typical camera can view 800 m during the day or night; can be remotely controlled for zoom, focus, pan, and tilt.
- Cameras normally spaced at 1000 m intervals to give full freeway coverage. Additional cameras required where obstructions to view, e.g., a multi-level interchange.

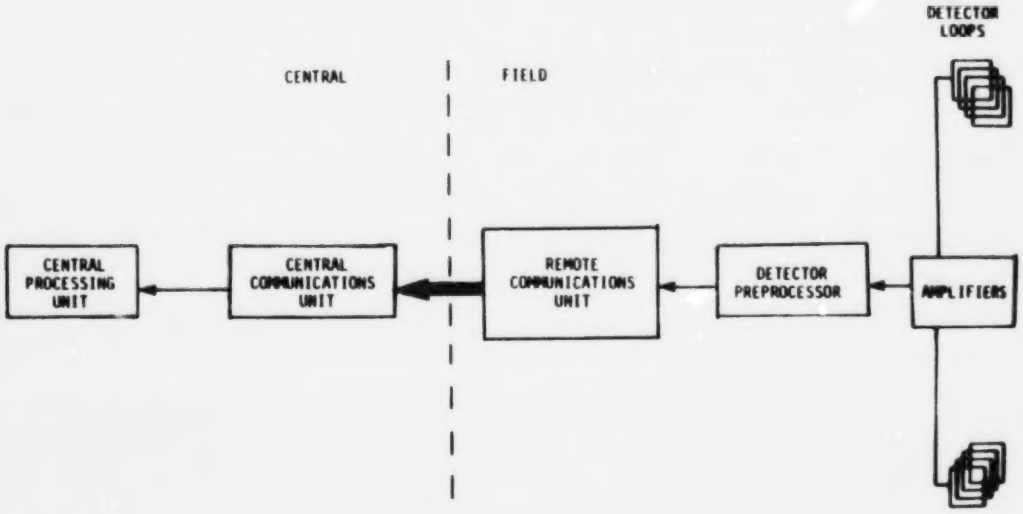


Figure 3/ Detector System Configuration

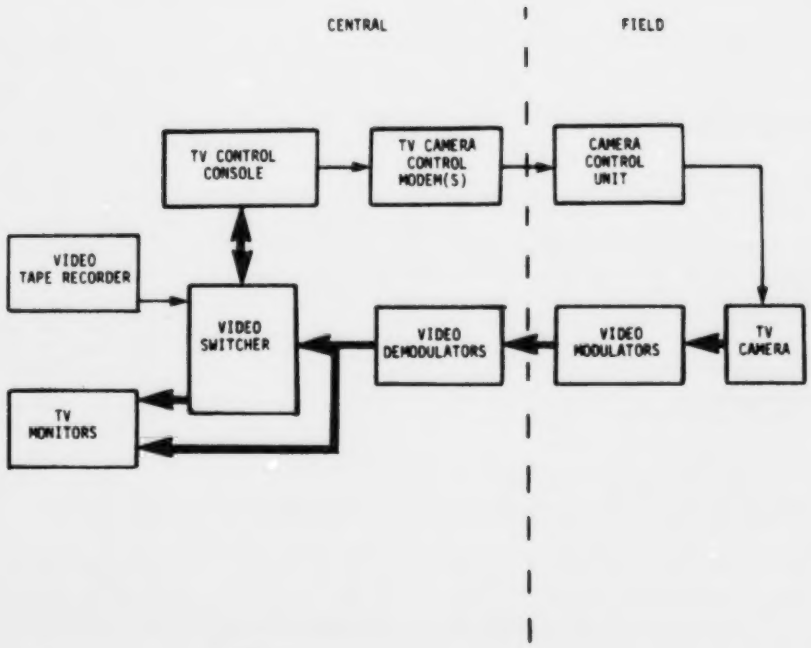


Figure 4/ CCTV Subsystem Configuration

4.3/ Changeable Message Sign (CMS)

Function

- Inform motorists of unusual or unsafe road conditions for accidents, incidents, weather, congestion, maintenance, or construction activities.
- Advise motorists of safe driving actions and advise of alternate routes during traffic diversions.

Components and Configuration

- Changeable message signs, sign trusses, local sign controllers, master sign controller, equipment cabinets (see Figure 5).
- Strategically located 900 to 1200 m in advance of decision points for alternate route selection. Average sign spacing is 3000 to 5000 m.
- Typical sign may be two or three lines of 24 characters each; electromagnetic "discs" in a modular matrix allow flexibility in message creation.
- Sign may be preprogrammed with messages and controlled locally or from master controller at control centre.

4.4/ Lane Control Sign (LCS) Subsystem

Function

- Advise of safe operating speeds and control lane usage.
- Prevent accidents, primarily secondary accidents.
- Manage traffic during incidents, accidents, and maintenance.
- Control merging traffic and stabilize traffic flow by encouraging uniform speeds.

Components and Configuration

- Lane control signs, trusses, local sign controllers, master sign controller, equipment cabinet (see Figures 6 and 7).
- Typically located on a truss, one sign centred over each lane. Sign trusses are spaced at approximately 750 m intervals.
- Typical signs are fibre optic, each with a variety of speed and lane-use symbols.

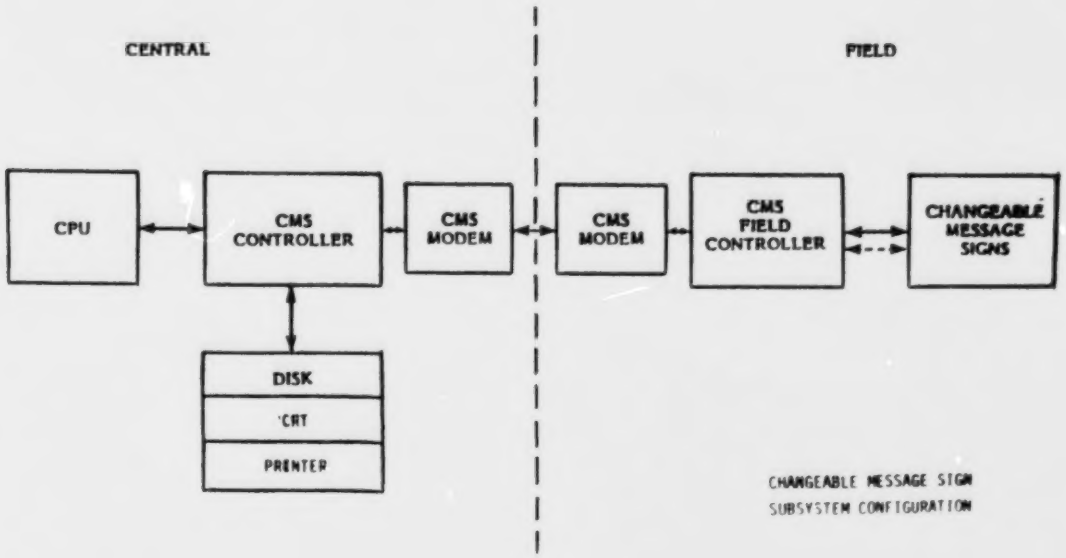


Figure 5/ CMS Subsystem Configuration

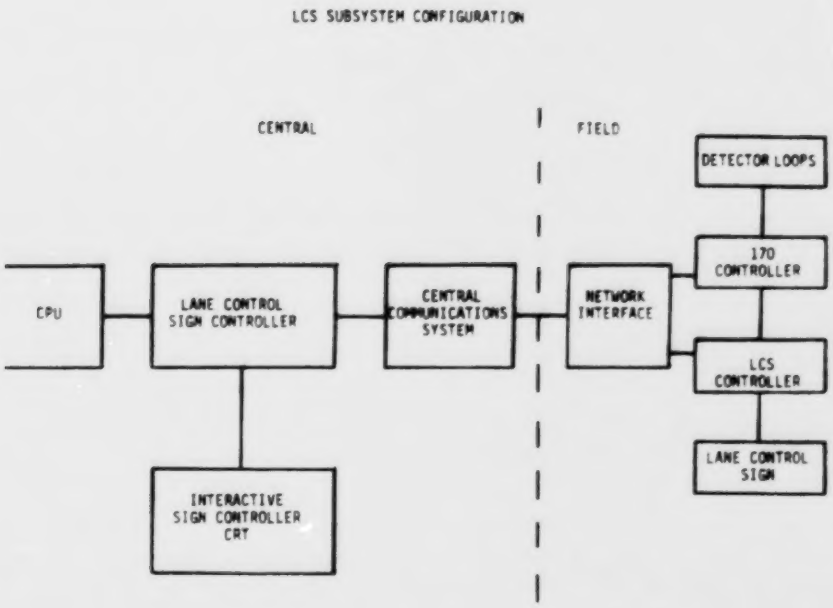
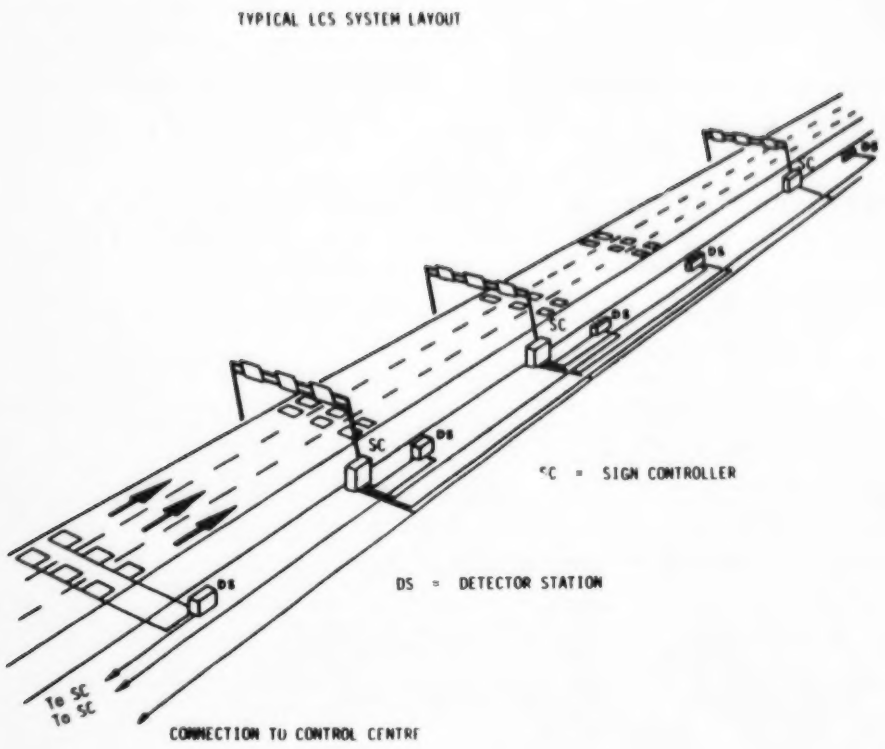


Figure 6/ LCS Subsystem Configuration



Source: Dutch Motorway Control and Signalling System, Rijkswaterstaat, Netherlands

Figure 7/ Typical LCS System Layout

4.5/ Ramp Metering Subsystem

Function

- Control the volume of traffic entering the freeway, to maintain freeway volume below capacity.
- Regulate the entry of vehicles onto the freeway, to smooth merging of traffic.

Components and Configuration

- Ramp control signs; stop bar; ramp detectors for demand, passage, and queue; mainline detectors; ramp metering warning sign; micro-processor, equipment cabinet.
- Typically stop bar is located 90 to 100 m upstream of ramp bullnose; ramp control signals are approximately 3 m downstream of stop bar.
- Ramps must have adequate vehicle storage capacity to prevent queue from backing onto the arterial road.

4.6/ Communications Subsystem

Function

- Link the FTMS control centre to all FTMS field elements and to other agencies such as police or municipal traffic control system.
- Transmit data and video signals.

Components and Configuration

- Communications cable and equipment, manholes, and cabinets.
- Twisted pair, coaxial, or fibre optic cable, aerial and/or underground in duct or direct buried, normally within highway right-of-way.

4.7/ Control Centre

Function

- Control and operate the FTMS.
- House computer and communications equipment and staff required to administer, operate, and maintain FTMS.
- Operate in peak period only, daytime, or 24 h/7 days/week, depending on need.

Components and Configuration

- Operations room, computer room, electrical room, staff offices, maintenance area, seminar and training room, washroom, public viewing area, and reception.

4.8/ Computer Hardware and Software

Function

- Receive and process information from detectors, signs, and ramp controllers.
- Monitor and process input from Cathode Ray Tube (CRT) terminal and operator control panel.
- Perform control logic to select sign messages and ramp metering rates and output commands.
- Interface with central communications unit and master sign controllers.
- Generate, format, and send reports to printers, tape, and CRT terminals.
- Generate and display graphic display and control panel information.
- Alert operator to equipment failures, incidents, and ramp queues.

Components and Configuration

- Typical configuration is central computer with field micro-processors, which perform extensive data accumulation and processing.
- Also includes CMS master controller, LCS master controller, and central communications unit.
- Software is an integral part of hardware selection and typically is the higher cost component.

4.9/ Service Vehicle Patrols

Function

- Provide routine emergency assistance for vehicles in distress, accidents, or for removal of debris on the freeway.

Components and Configuration

- Typical vehicles are car, half-ton pick-up, van, or truck equipped with towing device.

- Most vehicles equipped with bumper for pushing disabled vehicles from roadway.
- Vehicles also equipped with emergency equipment to service disabled vehicles and accident sites.
- Vehicles equipped with two-way radio to dispatch and receive from control centre.

5/ FTMS PLANNING

5.1/ Traffic Data Acquisition and Analysis

5.1.1/ The Need for Data Gathering

Although, conceivably, an FTMS could be implemented without a comprehensive data gathering program prior to implementation, the effectiveness of such a system would be severely reduced. The observation and analysis of the original conditions allows the planner to identify with a higher degree of certainty locations and sources of problems. Once the problem is identified, the information is also necessary for formulating the most appropriate, effective strategies and to perform a benefit/cost analysis. After FTMS implementation, original condition data is invaluable for evaluating system performance and optimizing system operation.

5.1.2/ Data Required

In many jurisdictions, traffic studies are carried out on a regular basis, and this information can be a major portion of the data base required for FTMS planning. However, some special studies will be necessary.

The following is a brief listing of data required for planning and system evaluation purposes:

- Annual Average Daily Traffic (AADT) volumes for the freeway, ramps, and the neighbouring arterial street systems;
- peak-hour volumes (traffic volumes during the highest hour(s) of loading and/or congestion) measured for the freeway, ramps, and major parallel arterials;

- speed-delay measurements, between key points on the freeway;
- origin/destination studies, another specialized activity which will indicate the travel patterns of the freeway users;
- collision experience, which includes the number, location, time, and type of accidents on the freeway;
- incident occurrence, specifically the frequency, location, and duration of vehicle breakdowns.

5.1.3/ Data Analysis

Analysis of the data gathered will often aid in the identification of problems/needs, the evaluation of proposed strategies, and the optimization of the implementation system.

Records of AADT and peak volumes should be analysed for each freeway section to determine capacity problems, operational problems, and to estimate future demands.

Collision experience should be charted for each section, particularly noting high-accident locations, times, and types. The adjacent arterial network should also be analysed to determine the potential for corridor optimization and to examine the effects of any FTMS strategy on parallel arterials.

Once accidents, incidents, volumes, and peak-hour speeds are known for each section, potential delay savings can be calculated for each strategy.

5.2/ Identifying Needs and Problems

A thorough data analysis on a section-by-section basis will identify most present operational, capacity, and accident problems. It is important to attempt to take into account future problems on the freeway because the FTMS may aid in preventing or forestalling these problems.

Consultation with other jurisdictions/departments and user groups increases the understanding of problems and needs. Law enforcement,

highway maintenance, transit, emergency services, and arterial street system authorities should also be consulted. Close liaison with these groups in the planning stages will ensure more effective operation once the FTMS has been implemented.

An FTMS can be useful for motorist advisory and traffic-flow management during complicated construction programs. An FTMS may also be necessary in order to aid in the management of special events (e.g., the 1984 Los Angeles Olympics employed an extensive FTMS system).

5.3/ Strategy Formulation

5.3.1/ Considerations

Once the major needs and problems have been identified for the freeway (and its surrounding area), the application of the strategies mentioned in Section 3.2 may be considered.

In most cases, a comparison of the resulting benefits to the costs of the strategy will be the most important consideration and will be discussed in further detail in Section 5.4.

Other factors are also worthy of consideration. The technical viability of any strategy must be ensured, usually by examining the results achieved by another jurisdiction. Some strategies may require changes in the population's driving habits and attitudes to be successful. Some type of driver education program may have to be implemented with the strategy.

Any strategy implemented must take into account the technical experience and expertise of those responsible for operating the FTMS. The strategies must be flexible enough that they can be expanded and built upon as the operating experience of the personnel grows.

Freeway traffic management system strategies should be co-ordinated and integrated, where possible, with the transportation strategies of the neighbouring transit and arterial street systems.

5.3.2/ Formulation of Alternatives at a Conceptual Level

It is beneficial to formulate several alternative solutions for the identified problems/needs and then evaluate each alternative using a common methodology. Each alternative is based on a different strategy or package of strategies detailed at a conceptual level. Alternatives often differ substantially in level of complexity and cost.

A conceptual level of detail usually includes approximate estimates of limits, quantities, and costs of system elements (field equipment, control centre, etc.) and estimates of the benefits to be gained from the particular strategies being employed.

5.4/ Evaluation of Alternative Concepts

Once alternatives have been prepared at a conceptual level, they can be evaluated on the basis of a benefit/cost analysis and non-quantifiable benefits.

5.4.1/ Benefits

Benefits are measured with respect to improvements over existing conditions. Each strategy or package of strategies offers certain savings, usually based on experience in other systems or sometimes on a theoretical basis. These savings are based on reductions in delay (from both recurring and non-recurring congestion), accident reduction, and maintenance activity reduction, all of which can be given a dollar value. Some benefits are more difficult to quantify, such as construction management, technology transfer, relief of driver frustration, and public relations.

5.4.2/ Costs

Costs of each alternative are usually composed of implementation costs and operating costs.

5.4.3/ Analysis

Calculation of the benefit/cost ratio is based on a period consistent with the expected life of the field equipment. A discount rate (as determined by jurisdictional policy) may be employed, and a minimum acceptable benefit/cost ratio must be chosen.

5.5/ FTMS Preliminary Design

After an alternative (detailed at a conceptual level) has been selected based on the highest benefit/cost ratio and non-quantifiable benefits, a preliminary design is prepared. The preparation of a preliminary design prior to detailed design will aid in solving any design problems at a general level, will give a fairly detailed estimate of capital cost, and will allow decision-makers to have a relatively detailed look at what they are approving.

5.6/ FTMS-Compatible Design for Highways

There are several design characteristics which are usually included in highway geometric design but have a large impact on the effectiveness of an FTMS. The following elements should be taken into account at any location where FTMS work is planned:

- ramp design appropriate for ramp metering
- full-width paved shoulders
- accident evaluation areas
- maintenance access to FTMS field equipment
- communications corridor
- line of sight for CCTV

Even for freeway sections where an FTMS is presently not required or justified, it is wise to use FTMS-compatible designs to preserve future options.

Provisions for a proposed future FTMS can be included in ongoing road contracts. Economics of construction can be realized while pavement disturbance and traffic disruption are minimized. Detector loops, junction boxes, electrical manholes, underpavement crossings, power tap

points, and equipment foundations are some examples of typical provisions.

6/ FTMS IMPLEMENTATION AND OPERATION

There is a significant amount of detail involved in each of the following topics. The intention of this section of the paper is to provide a brief outline on the key issues relating to the implementation and operation of an FTMS.

6.1/ Detail Design

6.1.1/ Various Approaches

There are basically two approaches for detail design of FTMS projects. A consultant may be hired to furnish the detail design activities, or this requirement can be carried out internally. The end product is generally a detail design package containing sufficient information for use in construction.

6.1.2/ Contract Package Requirement

The contract package should be precise, complete, and reasonable for all parties involved. For any dispute before, during, or after construction, this package should be the location where answers can be found.

6.1.3/ Hardware Standardization

Standardization is desirable for the equipment chosen in each subsystem and for components that are common to the FTMS. Hardware standardization can affect the entire planning, detail design, construction, operation, and maintenance cycle.

6.1.4/ Software Development

The applications software will gather, process, and analyse the detector data and then produce response plans. The software is tailored to the FTMS and the hardware of the computer. The cost and time for development

depends on the system size, FTMS complexity, and the expertise of software personnel.

6.2/ Contract Preparation and Tendering

Due to the uniqueness of FTMS projects, it is suggested that pre-qualification of the prime and subcontractors be employed prior to tendering of the contract. This can provide greater assurance that the successful bidder has the ability to deliver the contract. The following are major activities involved in the pre-qualification and tendering processes:

- advertising
- project information circulation
- submissions by contractors for pre-qualification
- pre-qualification evaluation
- notification of qualified contractors
- tender submissions by qualified contractors
- tender opening and award

6.3/ Construction

6.3.1/ Contract Supervision and Testing

Good supervision is essential to monitor the progress of the contract and to ensure that the contractors are fulfilling their responsibilities.

It is necessary to carry out a testing program in order to verify the equipment being shipped and installed by the contractors will operate as specified in the contract. The tests are usually performed during different stages of the contract and include factory acceptance, proof-of-performance, and final acceptance tests.

6.3.2/ Common Problems

Construction problems vary with location, size, and complexity of the project. The following are some of the common problems that are associated with FTMS projects:

- inexperienced prime and subcontractors
- inexperienced construction supervisory staff

- delay of equipment delivery
- non "off-the-shelf" equipment
- quality control
- co-ordination with adjacent non-FTMS contracts
- contract package interpretations

6.4/ System Start-Up

6.4.1/ Public Education

To gain acceptance, co-operation, and compliance, the general public has to be fully informed about the new system. An education program should be established for the public to become familiar with operational characteristics, components, and benefits of the FTMS.

6.4.2/ Equipment Debugging

After the installation and stand-alone testing of each piece of equipment, it will be interconnected and operated as part of a complex system. Often, many types of equipment are supplied by different manufacturers and built to different industrial standards. When such a complex system is interconnected, there is a need for an equipment debugging period. The length of this period depends on the system size, how well the interface specifications for each piece of equipment were prepared, and how thoroughly the individual testing was performed.

6.5/ Operations

6.5.1/ Manpower Requirements and Organization

Requirements may vary with the size, types of subsystems, and period of operation. Apart from allocating enough manpower to operate the system, it is also important to recognize that there is an ongoing need to maintain the system (see Figure 8). Staff who are responsible for system operation and maintenance should receive proper training related to the background, aim, system components, and theory of operation of an FTMS. A scheduled maintenance program should be set up and sufficient spare parts and equipment should be available to handle routine and emergency

repair activities.

6.5.2/ Liaison with Outside Agencies

Apart from the general public, outside agencies may have an interest and uses for the system. It is important to promote the features, benefits, and importance of an FTMS so that interested or affected agencies can benefit as well.

7/ ACKNOWLEDGEMENTS

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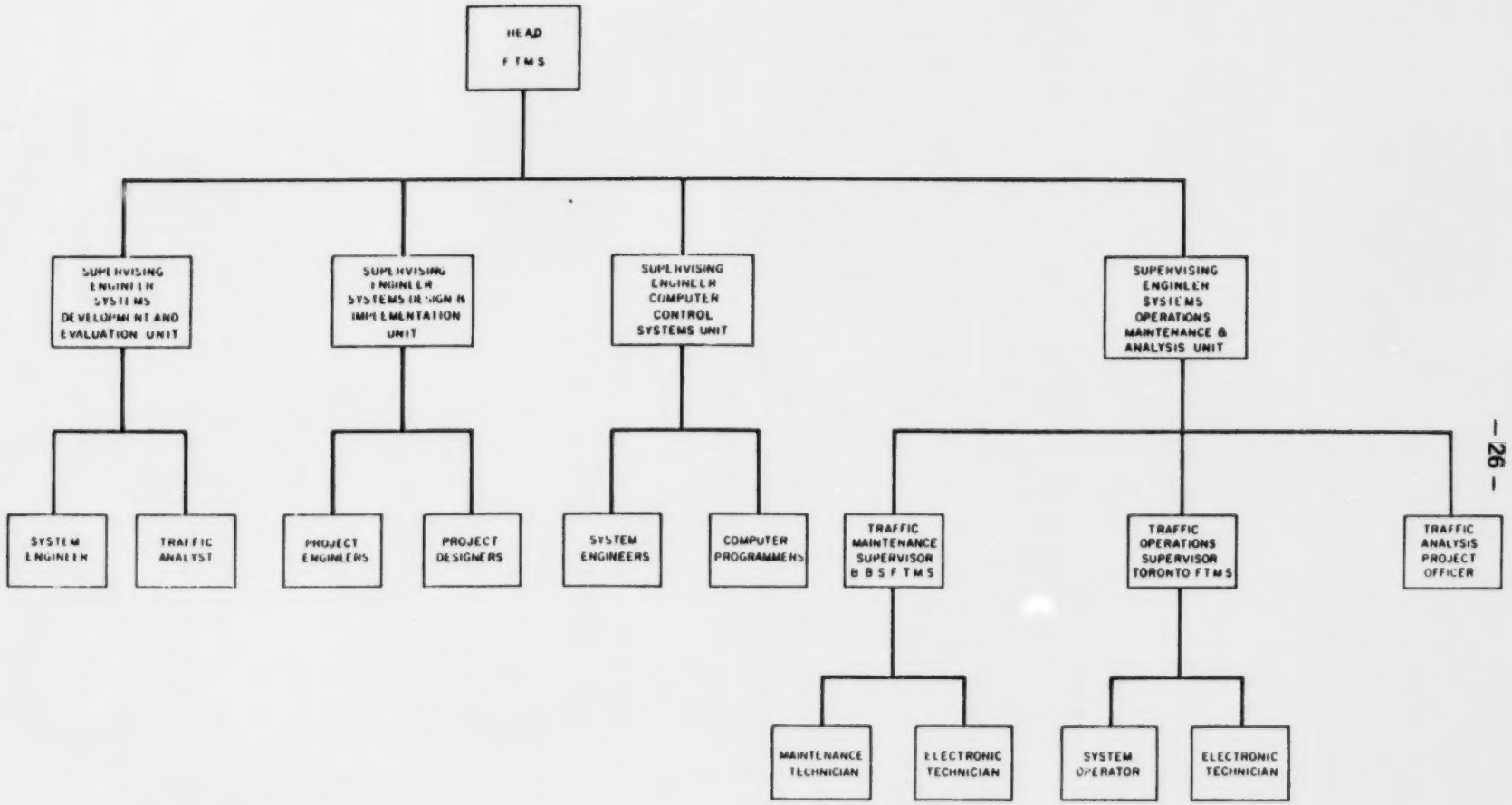

Figure 8/ Ontario FTMS Organization

Ontario

Ministry of
Transportation and
Communications
Hon. Ed Fulton
Minister